CHAPTER 9 STRUCTURE STUDY

An evaluation of 500kV tangent tower types for the proposed transmission line is shown. Costs, and various aspects and impacts of the different towers are discussed prior to a recommendation.

The structure study considered a variety of commercially available tower types used in the construction of 500kV transmission lines. Lattice towers are the preferred construction type for the project for 345kV and 500kV alternatives. Lattice towers offer a more efficient solution to the long spans and heavy mechanical loadings for the higher voltage lines. In some instances tubular steel poles are required. These towers are heavier and costlier than their lattice counterparts, but they do offer solutions for right of way concerns.

9.1 GUYED TOWERS

One of the first decisions to be made for the line is whether guyed towers can be used. The most recent high voltage transmission line (AEP's Wyoming-Jackson's Ferry 765kV Line - 2006) utilized a guyed-V tower design. 500kV transmission lines built in the west over the last twenty years, however, have all been unguyed, self supporting lines. The following are decision factors for guyed tower use.

- **Cost** – Guyed towers utilize less steel so save money in material and labor installation costs. For the guyed tower line design considered for this study (guyed-V), project costs are approximately 10-15% less than for a self-supporting equivalent line.

  For three different guyed tower types considered, their relative weights to one another are shown below.

Tower Type	% Weight of of Self-Supporting
Guyed-Delta	75%
Guyed-V	70%
Cross-Rope Suspension	40%

  See Appendix E for a graphic of the various tower types.

- **Reliability** - A guyed tower can be structurally advantageous during a catastrophic or major weather event. The guys allow the tower to deflect much more than a self-supporting tower, thus reducing stress on a tower and dissipating energy. Of the three guyed tower designs, the cross rope suspension tower is the most structurally stable due to its wide guying profile. The guyed-V is next and the guyed-delta tower the least reliable of the structures. The guyed delta tower's configuration can create an unstable structure when one of its guys are broken or removed.

- **Vandalism** – One of the primary reasons guyed towers have not been built recently is their susceptibility to vandalism. Someone bent on destroying a tower, or simply "having fun", could do so with a hack saw on a tower guy. This has been the case with at least two western high voltage lines in the last twenty years. Self-supporting towers are much less susceptible to vandalism.

- **Right of Way** – The diagrams in Appendix E indicate the footprint of each of the different tower types in relationship to one another. Obviously, any of the guyed tower configurations take up significant space when installed. If property owners or governmental land managers are not amenable to guyed configurations, self supporting towers or even pole structures are often required.

- **Anchors** – For guyed towers, guy anchors represent the major force resisting component of the tower. Their susceptibility to corrosion over time is of some concern as some lines have experienced anchor corrosion as determined by non-destructive evaluation.

- **Construction** – Anchoring costs for guyed towers are compared to tower foundation costs for self-supporting equivalent towers. In typical soils, an anchor will be a less expensive installation. In rocky soils, and particularly lava rock with many fissures, anchoring will be difficult and may be more expensive than foundations.

  Guying the towers in terrain with significant relief can be a significant problem. Excessively long guy leads coupled with greater right of way requirements will dictate self-supporting towers in mountainous terrain.

9.2 SELF-SUPPORTING LATTICE TOWERS

Self supporting lattice towers have been the standard installation for much of the western United States for 500kV transmission. Self supporting tower configurations are either flat or delta. A delta configured tower offers a slightly narrower base and taller overall height and a more advantageous electric and magnetic field profile within the right of way. These fields are focused in the center of the right way and taper off rapidly toward the edges while a flat configuration tower's EMF profile will be more uniform throughout the right of way. A delta tower will weigh slightly more than a flat configured equivalent tower.

9.3 POLE STRUCTURES

Some areas of the transmission line may require pole type structures. These structures, although common for lower voltages, are not as efficient for the long spans and heavy wire for the 500kV transmission lines. A pole structure may be required in agricultural lands for utilization of property, or for environmental purposes where a pole structure may offer better visual or other environmental advantages. Single poles and H-frames were reviewed for purposes of this study.

9.4 COMPARISON

For purposes of this evaluation, a triple bundled 1590kcmil ACSR conductor configuration was considered with the loading criteria described in the design criteria. Estimated tower weights and various characteristics are discussed below.

Type	Weight	*Installed Cost/Mile
SS Lattice Flat	45,000	$402,000
SS Lattice Delta	47,250	$411,000
Guyed-Delta	33,750	$313,500
Guyed-V	31,500	$304,500

Cross Rope		
Suspension	18,000	$241,500
H-frame	39,200	$492,500
Single Pole	38,100	$510,000

*Installed Cost includes only those items included in structure installation – structure, structure attachment material, foundations, and foundation material, guy and anchoring material for guyed structures. This cost only assumes tangent structure installations – 1450’ average spans for lattice, 1250’ average spans for tubular.

9.5 MAINTENANCE

One of the critical factors in tower design is the maintainability of the line. 500kV transmission lines are responsible for the movement of significant energy and having them out of service is tremendously expensive. Because of this, the ability to perform live line maintenance on the structures is becoming more important. As such, a tower should be designed that has sufficient clearances for live line maintenance. Appendix F shows sample tower configurations that were designed for live line practices. The electrical spacing and conductor configuration shown will be much larger than needed for code requirements but will allow for safe working clearances.